MONITORING AND MANAGEMENT AEROSPACE SYSTEMS

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Abstract. *In the article the issue of prospects development of airspace and air traffic of Europe is considered. Main problems of the existed air navigation system have been reviewed. Some actions to be undertaken in Ukraine to improve its airspace indicators and increase the number of aircraft served by ATS units have been proposed. A performance based navigation concept is used by authors as a method to solve the problem. The concept is based on the principal of strict focus on desired results and well informed decision making process. The structure of the Master Plan and its stepwise implementation in the Europe airspace is described. The methods proposed to follow the plan structure appropriately have been reviewed. The performance based navigation concept can serve a key point in researches aimed at finding efficient ways to develop airspace and air traffic in Europe. The role and functions of ATS units within the framework of the performance based navigation concept are considered. In future more research of this issue will be conducted and new results will be published.*

Keywords*:* Air Traffic Management (ATM), Master Plan, Single European Sky (SESAR).

Introduction

International Civil Aviation Organization defined the performance based approach. According to the decision this approach should be based on the following three principles:

– Strict focus on desired results;
– Well informed decision making process;
– Reliance on facts and data for decision-making.

The first steps to make the transition have been carried out were identified. The performance expectations were set using which the Air Traffic Management ATM industry should deliver and established a SESAR performance framework, setting performance objectives for each of them, with associated indicators and targets. In response to the performance objectives and targets, there have been defined the target concept and outlined the overall deployment sequence for implementing it. There why the sequence should be expressed in terms of operational improvement steps and associated enablers.

Due to this framework in November 2005, during the public announcement of the SESAR definition phase contract, the EC objectives of the SESAR program were expressed. According to it a future European ATM system should be achieved for 2020 and beyond which such statements can be implemented as 3-fold increase in capacity which will also reduce ground and air delays, improving of safety performance by a factor of 10, reducing of flights effect on environment onto 10% and 50% less cost of ATM services providing for airspace users.

These statements constitute the political vision and goals for the design of the future ATM system. These vision and goals have been analyzed by reference to the 2020 demand and has resulted into specific initial targets for that particular year, notwithstanding the subsequent evolutions necessary to meet the growing demand. It shall be noted that the ATM system will further evolve after 2020 in order to sufficiently address the political design goals. For this reason the following particular recommendations were concluded. Business and regulatory management frameworks should be created. It will work to a common performance framework based upon that developed by International Civil Aviation Organization (ICAO),

and will have a dynamic working relationship between them to ensure the best outcome is achieved for the ATM industry as a whole. Then the ICAO global ATM operational concept should be used as the reference for the development of the ATM system and stakeholders have to establish an ATM performance partnership.

Concept of operations

The principles of operation were developed. According to it trajectory management introduces a new approach to airspace design and management. Collaborative planning continuously reflects in the network operations plan. The integrated airport operations contribute to capacity gains. New separation modes allows for increased safety, capacity, and efficiency. An increased reliance of airborne and ground based automated support tools. System wide information management integrates and properly disseminates all ATM business related data.

The ATM management process should be supported. For this reason there was identified the need for business management and regulatory management frameworks. They both work to a common performance framework.

The business management framework should be established by an ATM performance partnership in order to reconcile the different partners' business and mission objectives, identify those aspects of their visions which are common in terms of creating and managing the future ATM system and defining how the partners should interact to create and manage the future system.

This established ATM performance partnership is intended to be based on the principles of European ATM enterprise architecture (EAEA). European ATM should be considered as a virtual single enterprise in which the constituent parts work together in a networked, service-based operation with the business processes driving the services. The concept of this virtual single enterprise is instantiated in the European ATM enterprise architecture. It encompasses the structure and behavior of the virtual single enterprise's ATM related processes, functions, information systems, personnel and organizational sub-units aligned with the performance partnership's goals and strategic direction as defined by the Master Plan.

European ATM enterprise architecture was established to facilitate the ATM performance partnership. A single system design function needs to be formed as referenced in SESAR deliverable for the design of the technical architecture of the future ATM system. The role of this function is to be accountable for the system's overall design. Actually it should define the high level ATM system requirements needed to meet future business needs and ensuring the coherent integration of air and ground systems throughout the whole system. The initial design of the ATM system and its subsequent changes are approved through the decision making process.

To make an EAEA widespread a service-oriented approach should be taken. It can be the key enabler to allow aspects of the future ATM system to respond more quickly to rapidly changing business needs. These need to be brought together in a coherent and consistent manner. In general a service is defined as the delivery of a capability in line with published characteristics including policies. The EAEA must clearly distinguish the ATM business services that have to be provided from the underlying technical supporting services and the physical assets that will need to be deployed.

Structure of Master Plan

SESAR has defined six levels, which will progressively be deployed (fig. 1). Capability levels are associated with stakeholder systems, procedures and human resources. Upgrading a stakeholder to a higher capability level means deployment of new enablers, and this requires investments other words it needs costs. Service levels are associated with operational services offered by a service provider and consumed by a service user. Improving a service to a higher service level means deployment of operational improvement steps, and this leads to benefits and new performance improvements can be performed. Rising of service at a next service level 1 requires that both the service provider and the service user have at least evolved to capability level 2. Here it is necessary to note that backward compatibility is also required. Each system, which has a given capability level, should also be able to provide and receive services at a lower service level 3. This ensures interoperability between systems of different capability levels.

To see the main idea it is possible to consider an example. For instance an aircraft at capability level 3 is flying into a capability level 2 airport. The airport will provide and use service level 2. The performance benefits are those associated with service level 2. In other case the aircraft at capability level 1 is flying into a capability level 2 airport.

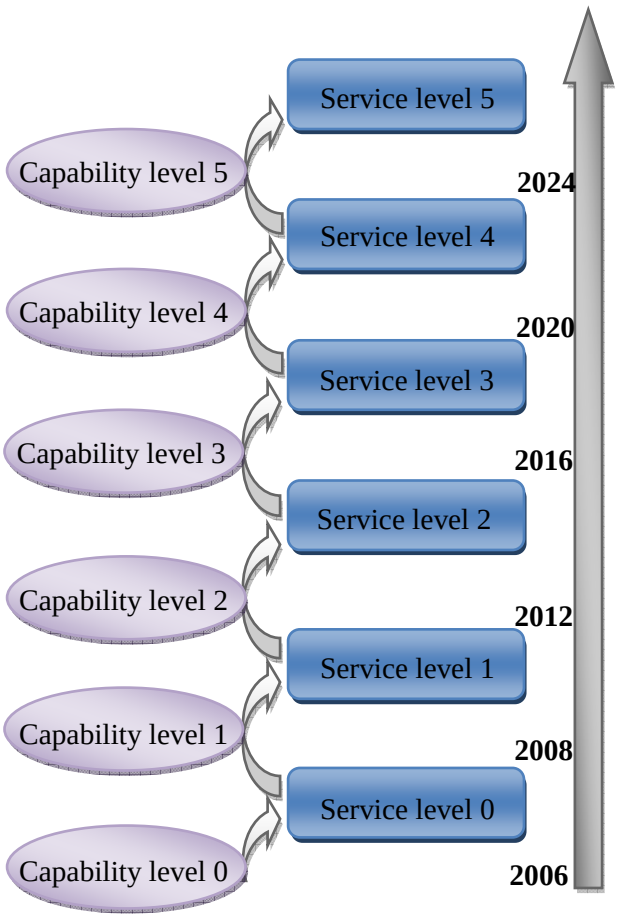

Fig. 1. Deployment of ATM Service and Capability Levels

They will provide and use service level 1. The performance benefits are those associated with service level 1.

Utilizing a service requires that both the service provider and the service user possess the required capability, but not necessarily all the capabilities of a particular level. It is clear that such capability mismatches will occur to some extent in a mixed ATM environment. But the general rule for deployment should be that air and ground deployment should be geographically synchronized as much as possible, to avoid capabilities to be wasted. These relationships are illustrated in fig. 2.

The role of ATM service and capability levels

The principles described above will come to life in the following performance based transition circumstances. The execution of the Master Plan will lead to timely availability of more advanced ATM systems, procedures, human resource enablers, standards, and supporting regulatory and legislative changes. For the sake of consistent and synchronized strategic planning, these have been grouped into ATM capability levels. Between today and 2020, research, development and industrialization is planned for rolling out capability levels 1 through 3, followed by the roll-out of levels 4 and 5 from 2020 onwards. The Master Plan also includes a Level 0, which corresponds to currently available systems and best practices for which deployment is already in progress, but not yet completed.

The aircraft, airports, and ATM facilities serving TMAs and enroute airspace will be progressively equipped as part of the stakeholder deployment plan by the stakeholders with these new capabilities where needed. The number of less capable units will diminish over time due to the need to accommodate the increase in traffic over the whole network. But the European ATM system will comprise aircraft, airports and ATM facilities of a variety of ATM capability levels at any given moment.

A new ATM capability level will introduce enablers designed to support operational improvements corresponding to a certain ATM service level. Generally speaking, in order to receive services at a given ATM service level, the aircraft as well as the service providers responsible for the area in which they are operating (airports, TMAs, Enroute airspace) must be at least equipped to the corresponding ATM capability level.

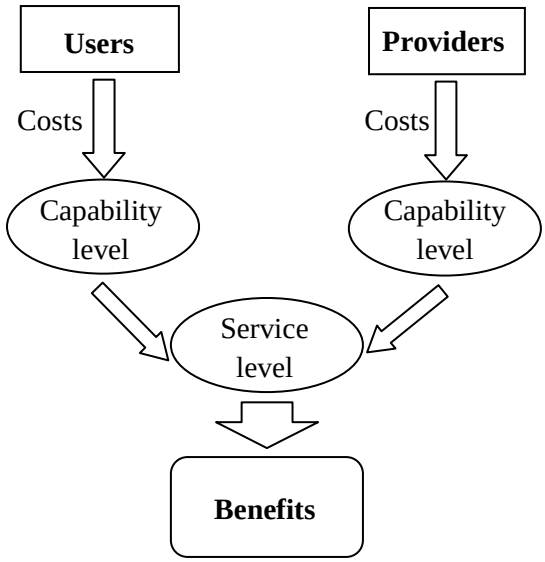

Fig. 2. ATM Service as a result of Capability Levels

The speed of deployment influences the value of benefits in a mixed environment. More advanced ATM service levels are associated with higher performance and deliver more benefits. At any one time, traffic composed of aircraft with different levels of ATM capability will be operating at a variety of ATM service levels in the European ATM system. It is important to ensure timely managed and efficient transition to the higher ATM service levels, and reduce the use of less advanced levels, because the greater the number of flights operating at the higher service levels, the greater will be the performance benefits overall. It should be mentioned that this regime provides a basis upon which to build financial incentives to promote the timely managed and efficient transition to higher service levels through, for example, differential pricing for different ATM service levels. In other cases to achieve the required speed of transition a mandate will be necessary.

The traffic demand grows and the plan is to ensure that new traffic makes use of the most advanced ATM service level, which is available at that moment. In addition, old traffic will also progressively migrate to more advanced service levels, albeit with some years delay. This will be the result of upgrading aircraft, flight operation centers, airports and ATM facilities with higher ATM capability levels. This does not mean or require that every unit will upgrade level by level. In a number of cases, stakeholders may wish to keep the number of retrofits to a minimum and decide to skip a level like to migrate from level 1 immediately to level 3.

Lifecycle Approach

The road map shows research, development and industrialization activities foreseen in the current version of the plan. The activities planned for the 2008-2013 periods have been incorporated in the Work Program. The research, development and industrialization activities fit in the context of a wider lifecycle based approach.

A standard decomposition of the ATM lifecycle has been adopted for master planning purposes. The complete lifecycle is subdivided into eight phases which are contained in three (fig. 3).

The change to a stakeholder system or an ATM service goes through a number of lifecycle phases, starting with research and development. It comprises identification of needs, concept definition, feasibility studies and pre-industrial development and integration. The second is implementation which comprises industrialization and deployment. The third stage is culminating with operational use and ultimately ending with decommissioning. The execution of each phase corresponds to an activity and that activity comprises the production of business case, safety case and validation.

Not all phases are addressed in detail in the Master Plan. The plan shows only the simplified lifecycle. An important milestone for Master Planning is the initial operational capability (IOC) date. This corresponds to the first time an operational improvement is needed to start delivering benefits. For enablers the initial operational capability date implies that a change has been deployed and is ready for operations. The enabler IOC dates are driven by the timing of the operational improvements they support. IOC dates are therefore central in the Master Planning process. All earlier lifecycle phase dates have been planned according to the target IOC dates. The point in time where full stakeholder deployment is made is called the full operational capability (FOC) date.

At the level of Master Planning, the major decisions are about:

1) is it necessary to start each lifecycle phase and when;

2) what to do during each lifecycle phase, all acts depend on synchronization needs with other activities;

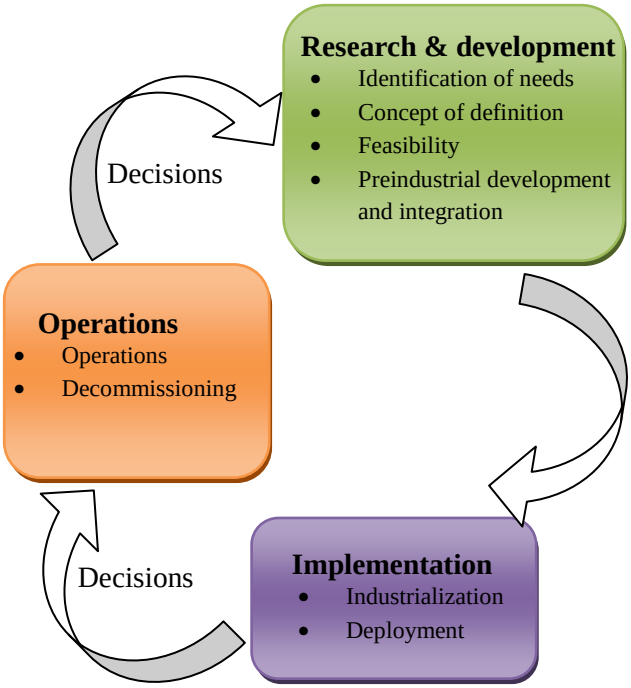

Fig. 3. Master Planning Lifecycle Phases

3) reaching agreement on the completion of each lifecycle phase, i.e. the achievement of milestones.

To start a lifecycle phase means to commit from all involved stakeholders in terms of schedule, financing and contributed resources. In the context of SESAR, the use of standard lifecycle phases for planning research, development and implementation activities has the some advantages. Lifecycle phases provide a framework which clearly scopes the type of work that has to be performed in the work program. They are designed to support a progressive refinement, development and validation from the high level concept to real, wide-spread operational use of a change and to manage the development risks such as feasibility, time and expenditure. The feasibility phase is relatively short and relatively low budget. It serves to ensure early reduction of uncertainty and allow timely re-orientation of the Master Plan if necessary, prior to the more expensive and time consuming pre-industrial development and integration. It is used to mitigate industrialization risks, and so on. Re-orientation of the Master Plan implies adjustments, prioritization or even cancellation of developments, possibly in other parts of the Master Plan. This re-orientation cross-check must ensure the consistency and synchronization of the various parts of the plan.

All said above underlines the importance of lifecycle related decision making. Each boundary between two phases is a checkpoint and decision point in the development and deployment of an operational or technical change. After each completion of a lifecycle phase, its results must be checked and used to update and maintain the Master Plan information. The decisions for follow-on activities should be based on the basis of the most up-to-date Master Plan information.

Master Plan management

The objective of Master Plan execution at the highest level is to realize ATM performance improvements not just of the required magnitude, but also in a timely fashion, so as to meet the performance targets required for a certain date.

There is still a risk that the improvements are not delivered in a timely fashion, due to slow progress in Master Plan execution, even if the target concept is capable of delivering improvements of the required magnitude, and that progress in delivering these improvements is indeed made.

To create the circumstances for mitigation of the risk of delayed lifecycle phase start, SESAR has identified the need for proper planning and management of decision-making. This is seen at two levels. The first is the overall system level, via the approval and buy-in to periodic Master Plan updates. The associated decision making is part of the Master Plan maintenance process. And the second is the level of decision plans for the key elements within the Master Plan.

Initial operational capability dates are central in the overall planning process. The major decision is to make a declaration of the IOC for an operational improvement or an enabler. The date at which this decision is planned must be really achievable, coordinated other words it should respect the logic of the deployment sequence and all dependencies and also be suitable within the larger context of performance planning. It means to enable timely delivery of performance.

The total collection of initial operational capability dates for operational improvements and enablers can be considered the initial operational capability plan. As part of the Master Plan maintenance process, coordination and suitability of these dates will have to be periodically revisited. Initial operational capability dates will need to be advanced or delayed when changing circumstances dictate so. Surrounding the IOC plan and governed by it are two decision plans which are different in nature but closely connected and jointly developed, covering the key elements within the Master Plan. The aim is to obtain commitment and achieve clear alignment of stakeholder plans with the Master Plan.

SESAR has identified a number of reasons why decisions need to be planned ahead. The most significant ones are the need for synchronization of research and development activities. Initial operational capability dates of enablers are driven by the planned initial operational capability dates of related operational improvements.

The requirements must be coordinated to prevent undue delay of the target start date. This again stresses on the need for careful decision planning, which should be followed by active management of the decision calendar. It is also may be mentioned that the required time horizon of the decision plan varies. For certain international decision meetings like the World Radio Conference the planning horizon needs to be several years. For other decision bodies which are meeting frequently a look ahead of one year will be more than sufficient.

There is no need to define all decisions right from the start. The current version of the master plan with its breakdown of activities into lifecycle phases and associated milestones and decision points can be considered as an initial version of the decision plan. The current information is not specific and detailed enough to make a meaningful assessment of what has to be decided by whom, using which consultation and decision making process.

The development phase of SESAR shows that it will be the responsibility of the SESAR union to progressively refine the decision plan on research and development matters based on more detailed analysis of the master plan with supplemental input from research and development results. Risk mitigation actions are pre-planned responses to the potential occurrence of certain events. When a risk event occurs, it is essential that the associated mitigation action can be launched without delay. Those responsible for the execution of the action must ensure rapid response decision-making.

Conclusions

The future of ATM in Europe will be guided by the master plan over the next decades and forms the basis for the program of work for the first part of the SESAR implementation phase. It will become a rolling plan that will be regularly updated in accordance with the results from the research and development activities starting under the responsibility of the SESAR.

It may be necessary to undertake a continuous performance monitoring to ensure that the future ATM activities will deliver the agreed benefits defined within an agreed performance framework.

This Master Plan will be handed over to the SESAR that is responsible for its execution and updates for the coming years.

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